In stating existing theory, one can do no better than to quote Johan Hjort, who, perhaps more than anyone else, was responsible for bringing attention to the importance of year-class success or failure as the explanation of fluctuations in the sea fisheries. In 1914 he advanced, and in 1926 (p. 32) reiterated, the theory that:

> The rich year-classes appear to make their influence felt when still quite young; in other words, the numerical value of a year-class is apparently determined at a very early stage, and continues in approximately the same relation to that of other year-classes throughout the life of the individuals.

It has already been shown that the observations on mackerel in 1932 are in harmony with this theory (p. 204).

Hjort (1926, p. 33) in discussing the great Norwegian cod and herring fisheries, suggested further:

> As factors, or rather events which might be expected to determine the numerical value of a new year-class, I drew attention to the following two possibilities:
>
> (1) That those individuals which at the very moment of their being hatched did not succeed in finding the very special food they wanted would die from hunger. That in other words the origin of a rich year-class would require the contemporary hatching of the eggs and the development of the special sort of plants or nauplii which the newly hatched larva needed for its nourishment.
>
> (2) That the young larvae might be carried far away out over the great depths of the Norwegian Sea, where they would not be able to return and reach the bottom on the continental shelf before the plankton in the waters died out during the autumn months of their first year of life.

Observations on mackerel do not support the first possibility. Mortality immediately after hatching was little, if any, greater than at other times, and hence failure of the 1932 class could not have been due to acute dearth of food at the hatching time. If shortage of food was responsible, it had its effect either throughout the period of planktonic existence or at the transition phase (9- to 10-mm.), well after the hatching time.

On the other hand, the second possibility has strong indications of support in the mackerel data. Not only did the heightened mortality at the 9- to 10-mm. lengths appear to be connected with drift of the larvae, but there also was a marked correspondence between success of the year-classes 1930 to 1933, and the drift that they must have experienced as the result of dominant winds in May of these four years.

That drift may in general be an important influence on success of year classes is further suggested by a similar finding for the American haddock (Walford, 1938, p. 55), wherein the relative failure of the 1932 class corresponded with drift of larvae away from Georges Bank, and relative success of the 1931 class corresponded with a pattern of circulation that kept the larval population on Georges Bank.

Thus, in the two instances where the events at sea have been traced, it was the oceanic circulation that influenced the success of year-classes; and in the one case where the course of mortality (in a failing year class) at sea was traced, it was not any, if at all, higher at the hatching time, and hence failure could not be attributed to acute shortage of food at this period.

In addition to the actual facts observed and their contribution to the understanding of year-class success or failure, the development of technique for determining mortality rates can have significant influence on future development of fishery science. If applied over a series of years, it would provide the data needed for separately evaluating the correlation of the size of the spawning stock with numbers of resulting offspring, and the correlation of the survival of offspring with the contribution of the year-class to the commercial stock. The predictive uses of such knowledge would be of obvious value to the conduct of fishing operations and to the trade in fishery products. But the value of such knowledge in formulating conservation policies would

be even greater than its value for predictions. These separate correlations would provide a basis for determining the size of spawning stock necessary to maintain an undepleted fishery. Efficient utilization will be possible when a reliable estimate can be made of the proper size of spawning reserve. Until then, there will always be danger of reducing the annual take, on the one hand, by attempting to preserve more spawners than needed, or, on the other hand, by catching more spawners than can be spared from the stock needed for adequate reproduction.

APPENDIX

METHODS OF DETERMINING SIZE AT MATURITY

Samples of fish were taken at various times at Woods Hole, Provincetown, and Sagamore, Mass., during the period June 24 to July 21, 1925. The fish were measured to the nearest half centimeter on a straight line from tip of snout to the extremity of the midcaudal rays. Gonads of the males were graded by eye as small translucent, small opaque gray, enlarged white, running milt, and spent. The last three grades were classified as mature. Gonads of females were graded by eye as small translucent, small granular, enlarged granular, translucent spots, running ripe, and spent. The last three grades were classified as mature. The results are summarized in table 13.

TABLE 13.—*Size of mackerel at maturity as indicated by 1,116 individuals taken by traps in the vicinity of Woods Hole, Mass., and in Massachusetts Bay during the period, June 24 to July 21, 1925*

Length, centimeters	Males			Females		
	Immature	Mature	Mature	Immature	Mature	Mature
	Number	*Number*	*Percent*	*Number*	*Number*	*Percent*
22.0	1			1		
22.5	1					
23.0	1			3		
23.5	10			6		
Total	13			10		
24.0	16			8		
24.5	22			16		
25.0	27			32		
25.5	25			33		
26.0	37	2		45		
Total	127	2	2	134		
26.5	35	1		47		
27.0	17	1		22		
27.5	18	1		27		
28.0	7	2		20		
28.5	10	2		14		
Total	87	7	9	130		
29.0	14	5		21		
29.5	12	7		16	1	
30.0	16	4		21	1	
30.5	9	3		17		
31.0	9	2		14		
Total	60	21	26	89	2	2
31.5	7	5		13		
32.0	11	7		12	5	
32.5	5	8		14		
33.0	5	11		9	6	
33.5	5	5		7	6	
Total	33	36	52	55	17	24
34.0	6	15		5	5	
34.5	6	29		8	7	
35.0	7	25		1	14	
35.5	3	28		4	8	
36.0	2	20		2	11	
Total	24	117	83	20	45	69

TABLE 13.—*Size of mackerel at maturity as indicated by 1,116 individuals taken by traps in the vicinity of Woods Hole, Mass., and in Massachusetts Bay during the period, June 24 to July 21, 1925.*—Continued.

Length, centimeters	Males			Females		
	Immature	Mature	Mature	Immature	Mature	Mature
	Number	*Number*	*Percent*	*Number*	*Number*	*Percent*
36.5	3	7			7	
37.0		6		1	3	
37.5		2		1	4	
38.0		2			2	
38.5		2			2	
Total	3	19	86	2	18	90
39.0		2				
39.5		2			2	
40.0		1				
Total		5	100		2	100
More than 40	1	23	96		14	100
Grand total	348	230		440	98	

METHODS OF COLLECTING EGGS AND LARVAE

Mackerel eggs and larvae were collected during the spawning season in the spring of each year from 1926 to 1932, inclusive. The initial work was exploratory and qualitative in nature. Tows during the period 1926 to 1929 were drawn horizontally at the surface, mid-depth, and just above bottom. In 1930 and 1931 oblique hauls were employed. In 1932, oblique hauls were continued, and a device employed to measure the quantity of water strained through the nets. The following description refers to the collections made during 1932.

Nets used.—The plankton net used during the first 7 cruises was 1 meter in diameter at the mouth, and 4 meters long. The first meter of length was cylindrical and composed of No. 0 millers' gauze with 15 meshes per lineal centimeter, and for the last 3 meters the shape was conical and the material of No. 2 gauze, with 21 meshes per lineal centimeter. At the end of the cone, attached by a coupling device, was a "cod-end" 5 inches in diameter and 10 inches long, of No. 12 gauze, in which the catch collected. During the ninth and tenth cruises, a stramin net was used, which was 2 meters in diameter (at mouth), and of the same proportions as the meter net.

Method of towing.—To sample uniformly throughout the range of vertical distribution of eggs and larvae, the method of oblique towing was used. This consisted of paying out an amount of line appropriate for the maximum depth to be reached by the particular tow, then hauling back a certain amount of line at fixed intervals of time, usually 5 meters every 2 minutes or 2 meters every 1 minute, until completion of the haul. During the period of hauling, the speed of the ship was kept as nearly uniform as possible.

During the first seven cruises, when 1-meter nets were used, one net was towed at the shoal stations where the water was nearly uniform from surface to bottom, and two nets at the deeper stations where thermal stratification of water was prevalent. At the stations where two nets were used they were attached to the towing cable at intervals estimated to be appropriate for the upper net to sample down to the thermocline and the lower net a nearly equal distance below the thermocline. In a typical instance, with a sounding of 50 meters, the lower net would be attached at the end of the line, the upper net 25 meters from the end, and another 25 meters payed out, making 50 meters of line all told. Towing at the usual speed, the line would stray

45° above the first net and 28° below it. The depth ranges of fishing would then be 0–18 meters and 22–44 meters, respectively, for the upper and lower nets. Since the course of plankton nets through the water usually is undulating (Russell, 1925, pp. 603–604), the theoretically unfished gap between the nets and the theoretically stepwise character of hauls would both be practically obliterated and the sampling virtually uniform, except for the greater depth range covered in unit time by the lower net. The latter was taken into account in the subsequent treatment of data.

During the eighth and ninth cruises when the hauls were made with a 2-meter net, only one such net was used, and at the deeper stations it was sent down to a depth roughly equivalent to that reached by the deeper of the two nets employed on earlier cruises, so that the single, oblique haul of the 2-meter net sampled through approximately the same strata as the two nets of the preceding cruises.

Measurement of quantity of water strained by the nets.—It is obvious that two variables, speed of towing and degree of clogging, seriously modify the flow of water through plankton nets, causing variations in the catching capacity. To eliminate these sources of variability, a current meter was installed in the mouth of the net to measure the flow. The utility of current meters in measuring the volume of water passing through a plankton net depends on whether or not the flow past the meter is equal to or proportional to the average flow of water into the net. By towing, at usual speeds, a standard net with a current meter in the center of the mouth and another meter at the periphery, it was found (William C. Herrington, unpublished notes) that the flow past these two positions differed less than 10 percent. Since these positions were such as to register the maximum difference in rate of flow, if any existed, this evidence was taken as indicating uniform flow into all parts of the mouth of the net. Hence we regarded the registration of flow past the meter as directly measuring the flow through the entire opening.

The instrument used for measuring the flow consisted of the propeller mechanism and revolution counter from a dismembered Ekmann current meter, turning five to six revolutions per meter of flow at usual towing speeds. For precise determination the meter was calibrated over the range of towing speeds. The total revolutions turned during a tow were converted to speed by dividing by the duration of the haul, in seconds; and the equivalent rates of flow were found from the calibration graph. These are the rates used in the specimen computation of table 15.

While the current meter was used as a standard procedure, there were times when mechanical difficulties prevented proper registration. To provide basic data for comparable treatment of hauls made on such occasions, records were taken periodically, during each haul, of the towing wire's angle of stray and of the ship's speed as measured by timing the progress of the ship past a chip cast alongside. An estimate of the extent to which the net was clogged was made at the end of each haul. Relations between these observations and flow past the current meter gave average factors by which angles of stray or ship's speed could be translated to terms of equivalent current meter measurements. This afforded means of estimating the flow on those hauls which were not accompanied by reliable current-meter records. All the hauls of cruise I, and 5 percent of the hauls on subsequent cruises were of this class. For these hauls there was some error of estimate which may have been considerable for individual instances, but were, we believe, of random nature tending to balance each other, and so could have introduced very little inaccuracy into the general results, based on averages of a number of stations.

Only one current meter was available, and this was used in the upper of the two nets. When more than one net was on the line, the flow through the lower net was assumed to be the same as that through the upper net except as modified by clogging.

Four degrees of clogging were recognized according to the following definitions: 0—When net is hauled to deck, water runs freely out of net and cod-end so that no water is left by the time the net reaches deck. 1—Water runs out of net freely but out of cod-end slowly so that some water is left in cod-end when net reaches deck. 2—Water runs out of net so slowly that it remains above level of cod-end coupling when net reaches deck, but falls to level of coupling after a short interval of time. 3—Entire net visibly covered with clogging organisms and water stays above coupling so that special means must be taken for washing down net.

By the graphical partial correlation method (Ezekiel, 1930, pp. 143–145), it was found how much the relation between the angle of stray and the quantity of water strained was modified by the various degrees of clogging. The amounts by which clogging changed the average rate of flow for given angles of stray was +0.032, −0.03, −0.073, and −0.108 meters per second for cloggings of 0, 1, 2, and 3, respectively, on the clogging scale as above defined. For the hauls made without current meters in the nets, these values were added to the theoretical flow as estimated from the angle of stray. The magnitude of these corrections is given by their percentage relations to the average rate of flow, which were +8, −1, −18, and −26 for the respective degrees of clogging. These, of course, are averages for each of the 4 degrees of clogging. The extreme individual values were plus 37 percent and minus 29 percent, which indicates that the total flow through an extremely clogged net at times was only half as much as through a very clean net. Since the clogging is progressive during a haul, it is obvious that practically no water is strained toward the end of any haul in which the net becomes badly clogged. The hauling method employed in this work, therefore, would undersample the upper layers relative to the lower layers. This would be a serious difficulty if clogging were often severe, but during 1932 only 4 percent of the hauls were of third degree and 15 percent of second degree clogging; hence uneven vertical distribution of sampling did not often occur. No adjustment was made for this effect.

ENUMERATION OF EGGS AND LARVAE

Eggs and small larvae were so abundant in many of the meter-net catches that a sampling method was necessary to estimate the total numbers caught. The formalin preserved plankton catch was transferred to a wide-mouthed graduated receptacle, enough liquid added to bring the level to a certain mark (often 2,000 cc.), the contents stirred vigorously to mix uniformly, and a dipper then plunged into the mixture and withdrawn level full. The dippers were of the type made for dipping cream, each comprised of a small straight-sided cup with a long handle. Several sizes of dipper, each of known capacity, were used and one or several dipperfuls taken, depending on the size of sample desired. All fish eggs and larvae were removed from the sample. From the remainder of the catch, all larvae larger than about 5 mm. in length were removed. From the 2-meter net catches all the larvae were removed.

Mackerel eggs and larvae were separated from those of other species and further examined, counting the number of eggs at each of three stages of development and the number of larvae at each millimeter of length. Measurements were made with the aid of microscope and eye-piece micrometer for larvae under 7 mm. and with millimeter rule and unaided eye for larger ones. The measurement was from tip of snout to end of notochord in larvae, and to base of caudal rays in post-larvae. Dis-

525293—44——5

torted specimens were classed by matching them with straight specimens of known length.

The method of converting the counts to total catch was simple in the majority of instances because usually the mackerel material consisted either entirely of eggs and small larvae, so that the total catch could be computed directly from the known volume of sample sorted and the known volume of the plankton from which the sample was drawn; or entirely of large larvae sorted from the entire catch, so that a simple count represented the total. In a minority of instances, when both small and large larvae occurred in the same haul the total had to be computed from a combination of the sampled numbers of small larvae and the total numbers of large larvae.

The specimen tabulation (table 14) illustrating the computation is self-explanatory except for the treatment of those sizes of larvae which were too scarce to be adequately represented in the small sample. Referring to columns 2 and 3 of table 14, it is obvious that the numbers of 8-mm. larvae were too few to have been taken in the small sample and also that in sorting the remainder, larvae as small as 6 mm. and perhaps also 7 mm. were not fully removed. Therefore, the 3- to 6-mm. larvae, inclusive, in the small sample were taken as representing the catch of these sizes and the items of column 2 were multiplied by $\frac{2,000}{112}$ and entered in column 4. The numbers (2) in the 7-mm. category in the small sample (column 2) were taken as representing the numbers of larvae 7 mm. *and over*, which should then total $2\times\frac{2,000}{112}=36$ in the entire sample. Since there were known to be 6 larvae of 8-mm. length (column 3) in the catch, the entry of 6 was made opposite the 8-mm. class in column 4 and the entry of $36-6=30$ opposite the 7-mm. class. The count of larvae in the lower haul (table 14) included no larvae larger than those found in the small sample, and the total numbers of each size (column 8) were computed simply by multiplying the counts in the sample (column 6) by $\frac{1,500}{112}$.

TABLE 14.—*Specimen computation for converting counts of eggs and larvae to total catch on the standard basis of 17.07 cubic meters of water strained per meter of depth fished*

[Data relate to station 21491]

Classes	Upper haul					Lower haul						Total catch
	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12
	Count in sample of 28/2000 sorted for eggs	Count in sample of 112/2000 sorted for larvae	Count in remainder sorted for large larvae	Computed total catch	Standardized catch (Column 4 × 0.70)	Count in sample of 112/1500	Count in remainder sorted for larger larvae	Computed total catch	Contamination (Column 5 × 0.21)	Net catch (Column 8) − (Column 9)	Standardized catch (Column 10 × 0.63)	(Column 5) + (Column 11)
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Eggs: Stage C	2			143	100							100
Larvae (mm.):												
3		27		483	338	8		107	71	36	23	361
4		12		214	150	4		54	32	22	14	164
5		15		268	188	6	1	80	39	41	26	214
6		11	10	197	138	1	2	13	29	−16	−16	122
7		2	20	30	21	1	3	13	4	9	6	27
8			6	6	4				1	−1	−1	3

In this particular sample the special treatment concerned the larvae of 7-mm. and upward. This was not uniformly true. The completeness of removal of large larvae from the remainder varied with the character of the plankton with which they were mixed and also, no doubt, with the fatigue of the person sorting the material. Due to this variation each haul was treated according to the internal evidence provided by the counts therefrom. More often than not the relative counts of the small sample and of the remainder indicated completeness of removal of smaller than 7-mm. sizes from the latter so that the length of larvae concerned in the special treatment was usually 5 or 6 mm. rather than 7 mm. as in the sample given.

COMPUTATIONS OF CATCH PER STATION

Standard haul.—Since it was desired to have a number representing the total population of eggs and larvae at each station, regardless of depth, the catches were converted to the basis of a standard amount of straining per meter of depth fished. The standard amount selected was the average of actual performance, as measured by the current meter during the first seven cruises of 1932, which was 17.07 cubic meters of water strained per meter of depth fished. The average performance was taken rather than any arbitrary amount because it involved a minimum alteration of original data, and the resulting figures represent nearly the actual numbers caught, except for the last two cruises, when the adjusted two-meter net catches represent approximately one-sixth of the actual numbers taken. Where an upper and a lower net were employed, the standardized catch of the lower net was added to the standardized catch of the upper net after a correction for contamination was applied to the numbers found in the catch of the lower net. The computations are illustrated in table 15.

The procedure for 2-meter-net hauls was exactly the same as for 1-net hauls by 1-meter nets except that an additional factor of one-fourth was applied to offset the quadrupled cross-sectional area of the net's mouth. Other things being equal, this would have resulted in standardization factors about one-fourth as large as those for the 1-meter nets, but actually the 2-meter net was towed somewhat faster and its oblique path was somewhat more gradual due to a higher towing angle in relation to the amount of line hauled in at each time interval. Hence the average amount of water strained per meter of depth fished was about 6 times, instead of 4 times, as great as in the 1-meter nets, and the factors for standardizing accordingly averaged about one-sixth.

For both sizes of net, therefore, the resulting factors for standardizing given in the columns headed "S factor" in tables 17 and 18 are such as to convert the catches at each station to the equivalent of the numbers that would be found in a column of water with a cross-sectional area 17.07 square meters, and extending from the surface to the deepest level reached by the nets at each station. This may also be stated as being equivalent to 21.7 times a vertical haul of a 1-meter net of perfect straining capacity.

TABLE 15.—*Specimen computation of factors for adjustment of haul to standard basis of straining 17.07 cubic meters of water per meter of depth fished and for ascertaining contamination of catch of the lower net in passing through the upper stratum*

[The data relate to station 21491]

Item	Unit	Upper net	Lower net
1. Length of line payed out	Meters	0–25	25–55
2. Average stray	Degrees from vertical	51.3	35.0
3. Stratum fished	Meters	0–16	20–45
4. Thickness of stratum fished	Meters	16	16
5. Time fished (exclusive of time spent by the lower net in passing through the upper stratum).	Seconds	865	980
6. Rate of flow through net (from current meter)	Meters per second	0.574	
7. Clogging (on arbitrary scale, see text)		1	1
8. Adjustment for clogging	Meters per second		−0.007
9. Adjusted flow (item 6 plus item 8)	Meters per second	0.574	0.567
10. Total flow (item 5 times item 9)	Meters	496	556
11. Standard flow $\left(\text{item 4 times } 17.07\frac{4}{\pi}\right)$	Meters	348	348
12. Factor for adjusting to standard haul $\left(\frac{\text{item 11}}{\text{item 10}}\right)$		0.70	0.63
13. Time spent by lower net in passing through the upper stratum	Seconds		127
14. Flow through net while passing through the upper stratum (item 9 times item 13).	Meters		72
15. Factor to be applied to catch of upper net to find the number of organisms caught by lower net while passing through the upper stratum.			0.21

Correction for contamination.—The nets were lowered and raised without closing. Consequently when two nets were used, the portion of the catch of the lower net taken during its passage through the stratum fished by the upper net may be considered as a contamination. The amount of this contamination was computed from the known average concentration of mackerel eggs and larvae in the upper stratum, the known time spent by the lower net in passing through this stratum and the assumed flow through the net (the same as that registered by the current meter installed in the upper net after correction for clogging). The computations were made for each stage of egg and length of larva, and the resulting numbers subtracted from the catch of the lower net (table 14). In all instances, the corrections were substantial, and at many stations approximated the entire catch of the lower net. Important numbers usually remained after the correction at those stations where the upper net did not fish down to the thermocline and the lower net fished in the stratum above the thermocline for a time in addition to the time spent while it was being payed out and hauled back through this stratum. As might be expected from consideration of the laws of random sampling, the amounts to be subtracted were sometimes in excess of the amounts caught in the lower net. When this occurred, differences were negatively added to the catch of the upper net, these instances of over-correction offsetting other instances of under-correction, leaving the average undisturbed.

Relative catch of 1-meter and 2-meter nets.—A comparison of the catching efficiency of 1- and 2-meter nets is afforded by 19 instances during cruises VI and VII where both nets were hauled at the same station. The hauls were made, and the results were converted to the standard basis by the methods already described for both

nets, excepting that no current meter was employed to measure the flow of water through the 2-meter net. In lieu of this measure, the speed of towing was measured by timing the travel of the ship past a chip cast alongside. It was later found from a statistical analysis of the relation between chip speed and flow through meter nets as measured by the current meter, that the force of the wind modified the chip speed materially. From the relationship established, a schedule of adjustments was applied to the apparent chip speed, to convert it to an approximation of true towing speed. This apparent flow was used instead of a current meter reading. Because of the substitution of a deduced value based in part on average performance instead of on actually measured value, the two members of individual pairs of hauls are not strictly comparable, but the average, or sum, of the 19 hauls with each type of net is not subject to this fault.

From the distribution of sizes of larvae caught by the respective nets (table 16), it is obvious that the smallest sizes of mackerel larvae were almost entirely lost through the coarse meshes of the 2-meter net; that the 6- to 9-mm. sizes were incompletely retained; and that sizes from 10 mm. upward were fully retained by the larger net.

Two conclusions may be drawn from the comparison: (1) the catches of the two nets, per unit volume of water strained, are virtually identical for larvae 10 mm. and upward, and nearly so for the 7- to 9-mm. sizes, hence no material distortion can have resulted from the pooling of data from the two types of nets, according to the methods employed in this report. (2) Both types of net must have taken essentially all the larvae of sizes 10 to 22 cm. in length that chanced to be in their path, for if any larvae tended to dodge the nets they would surely have been relatively more successful in eluding the 1-meter net, and thus lowered its catch of the elusive sizes in relation to that of the 2-meter net. The closeness of the paired values for the size range specified is eloquent evidence this did not take place. It is to be regretted that no such paired hauls are available for the later cruises, when catches of still larger larvae might have indicated the upper size limit for effective catching of larvae by plankton nets.

TABLE 16.—*Comparison of numbers of larvae caught by 1-meter nets and by 2-meter nets at identical stations of cruises VI and VII*

[Catches of both nets were converted to the basis of straining 17.07 cubic meters per meter of depth fished]

Length of larvae (millimeters)	2-meter net	1-meter net	Length of larvae (millimeters)	2-meter net	1-meter net
	Number	*Number*		*Number*	*Number*
3	0.39	6,214	12	12.84	13
4	.61	230	13	9.50	10
5	1.76	143	14	5.86	5
6	7.40	56	15	3.14	4
7	17.33	33	16	.48	----
8	28.10	25	17	.48	1
9	20.28	37	18	----	1
10	13.75	24	20	.09	----
11	13.17	14	22	.09	----

TABLE 17.—*Record of oblique hauls made by 1-meter nets during cruises I to VII, inclusive, in 1932*

[For explanation, see items of table 15 designated by the figures enclosed in parentheses in the column headings of this table]

Cruise, locality, and haul	Station	Date	Hour	Upper net					Lower net						
				Depth (4)	Time (5)	Flow (10)	S factor (12)	Clogging (7)	Depth (4)	Time (5)	Flow (10)	S factor (12)	Clogging (7)	Time (13)	C factor (15)
CRUISE I															
Martha's Vineyard:															
I	21327	May 2	20	39	1,200	[1] 392	2.16	2							
II	21328	do	23	25	960	[1] 406	1.34	0	30				0		
III	21329	May 3	2	44	780	[1] 203	4.71	2	48				2		
IV	21330	do	7	54	1,380	[1] 538	2.18	2	72				2		
New York:															
II	21335	May 4	3	14	1,140	[1] 492	.62	0	17	1,324	392	0.94	3	[2] 116	0.06
III	21334	May 3	24	13	1,320	[1] 470	.60	2	17	1,444	507	.73	2	[2] 116	.09
IV	21333	do	21	15	1,260	[1] 521	.62	0	18	1,444	601	.65	0	[2] 116	.12
V	21332	do	18	15	1,320	[1] 465	.70	1	18	1,444	578	.68	0	[2] 116	.12
VI	21331	do	17	17	1,200	[1] 442	.84	0	15				0		
Barnegat: I	21336	May 4	7	19	900	[1] 292	1.41	2							
Atlantic City:															
I	21337	do	10	21	900	[1] 391	1.17	0							
II	21338	do	13	15	660	[1] 266	1.22	0	18	664	243	1.61	1	[2] 116	.11
III	21339	do	15	19	960	[1] 377	1.10	0	22	1,059	419	1.14	0	[2] 141	.12
IV	21340	do	18	19	900	[1] 367	1.12	0	22	999	410	1.17	0	[2] 141	.12
Cape May:															
II	21345	May 5	9	19	950	[1] 416	.99	1							
III	21344	do	7	14	805	[1] 309	.98	1	17	920	360	1.03	1	100	.10
IV	21343	do	5	18	880	[1] 368	1.06	0	22	900	292	1.64	2	139	.07
V	21342	do	2	18	820	[1] 306	1.28	1	22	900	380	1.26	0	154	.13
VI	21341	do	1	18	860	[1] 350	1.12	0	22	940	385	1.24	0		
Fenwick: I	21346	do	13	19	860	[1] 330	1.25	2							
Winterquarter:															
I	21347	do	16	21	900	[1] 394	1.16	0							
II	21348	do	18	16	845	[1] 386	.90	2	20	920	385	1.13	1	150	.17
III	21349	do	21	16	820	[1] 295	1.18	0	20	900	407	1.07	0	145	.12
Chesapeake:															
I	21352	May 6	8	22	765	[1] 322	1.48	0							
II	21351	do	5	20	900	[1] 394	1.10	0							
III	21350	do	2	16	805	[1] 363	.96	0	20	860	390	1.11	0		
CRUISE II															
Martha's Vineyard:															
I	21381	May 16	9	15	710	283	1.15	0	22	765	331	1.44	0		
II	21380	do	6	19	870	235	1.76	2	22	965	254	1.88	1		
III	21379	do	3	17	940	256	1.44	3	21	1,020	213	2.14	2		
Montauk:															
I	21375	May 15	15	22	910	364	1.31	0							
II	21376	do	18	18	915	389	1.01	0	22	960	441	1.08	0		
III	21377	do	21	15	895	283	1.15	2	20	965	298	1.46	1		
Shinnecock:															
I	21374	May 15	11	13	635	[1] 250	1.13	1	17	695	297	1.24	0		
II	21373	do	8	14	875	481	.63	0	19	925	503	.82	1		
New York:															
I	21369	May 14	18	19	895	421	.98	0							
II	21370	do	21	12	725	276	.95	0	16	795	329	1.06	0	140	.15
III	21371	do	24	16	840	[1] 298	1.17	1	20	900	344	1.25	0		
IV	21372	May 15	3	17	920	389	.95	0	22	965	442	1.08	0		
Barnegat: I	21368	May 14	14	17	700	267	1.38	0							
Atlantic City:															
I	21367	May 14	10	19	925	343	1.20	1							
II	21366	do	8	20	840	311	1.40	1							
III	21365	do	5	16	910	369	.94	0	20	945	376	1.16	1	150	.12
IV	21364	do	3	18	920	488	.80	0	22	975	550	.87	0		
Cape May:															
I	21359	May 13	11	17	780	294	1.26	0							
II	21360	do	12	13	595	281	1.01	0							
III	21361	do	15	22	760	284	1.68	0							
IV	21362	do	18	19	960	332	1.24	0	22	1,030	392	1.22	0	130	.09
V	21363	do	20	16	860	423	.82	0	21	910	479	.95	0	140	.15
Winterquarter:															
I	21358	May 10	11	22	845	212	2.26	2							
II	21357	do	9	13	720	292	.97	1	21	785	269	1.70	2	130	.08
III	21356	do	6	19	895	318	1.30	1	22	960	280	1.71	2	145	.07
Chesapeake:															
I	21353	May 9	16	9	480	190	1.03	0							
II	21354	do	20	21	860	406	1.12	1							
III	21355	do	24	19	865	326	1.27	0	22	1,010	415	1.15	0	155	.12

[1] The flow was deduced from angle of stray of towing wire and degree of clogging by means of correlation diagrams based on the relation between these and flow through the net as measured by current meter at all other stations of this series.

[2] Deduced from average data on subsequent hauls.

TABLE 17.—*Record of oblique hauls made by 1-meter nets during cruises I to VII, inclusive, in 1932*—Continued

Cruise, locality, and haul	Station	Date	Hour	Upper net					Lower net						
				Depth (4)	Time (5)	Flow (10)	S factor (12)	Clogging (7)	Depth (4)	Time (5)	Flow (10)	S factor (12)	Clogging (7)	Time (13)	C factor (15)
CRUISE III															
Martha's Vineyard															
I	21382	May 19	17	13	770	396	0.71	0	16	845	463	0.75	0	------	------
II	21383	---do----	20	16	840	264	1.32	1	20	905	315	1.38	0	------	------
III	21384	---do----	23	18	870	193	2.02	3	22	955	113	4.23	3	------	------
Montauk:															
I	21387	May 20	10	12	815	327	.80	2	16	885	299	1.16	2	------	------
II	21386	---do----	7	18	875	284	1.38	1	22	960	252	1.90	2	------	------
III	21385	---do----	4	16	1,000	243	1.43	2	21	1,110	154	2.96	3	------	------
Shinnecock:															
I	21388	May 20	14	16	965	328	1.06	1	------	------	------	------	------	------	------
II	21389	---do----	18	18	925	353	1.11	1	22	1,060	398	1.20	1	------	------
New York:															
I	21393	May 21	8	15	725	297	1.10	1	18	890	359	1.09	1	108	0.11
II	21392	---do----	5	12	755	374	.70	1	16	1,000	488	.71	1	129	.18
III	21391	---do----	1	15	995	438	.74	1	19	1,140	493	.84	1	154	.16
IV	21390	May 20	22	18	875	412	.95	1	22	1,030	478	1.00	1	146	.14
Barnegat: I	21394	May 21	13	18	760	170	2.30	2	------	------	------	------	------	------	------
Atlantic City:															
I	21395	---do----	17	16	690	271	1.28	1	------	------	------	------	------	------	------
II	21396	---do----	19	14	775	205	1.48	2	17	890	230	1.60	1	94	.08
III	21397	---do----	22	20	840	323	1.35	0	23	1,020	385	1.30	1	121	.08
IV	21398	May 22	1	19	955	465	.89	0	22	1,090	568	.84	0	------	------
Cape May:															
II	21402	---do----	14	13	555	233	1.21	0	------	------	------	------	------	------	------
III	21401	---do----	11	13	765	260	1.08	1	17	845	316	1.17	0	85	.09
IV	21400	---do----	9	18	895	337	1.16	2	22	955	300	1.59	2	113	.07
V	21399	---do----	7	16	850	508	.68	0	20	955	604	.72	0	128	.18
Fenwick: I	21403	---do----	17	16	765	264	1.32	0	------	------	------	------	------	------	------
Winterquarter:															
I	21404	---do----	20	17	860	469	.79	0	------	------	------	------	------	------	------
II	21405	---do----	22	20	925	324	1.34	1	------	------	------	------	------	------	------
III	21406	---do----	24	16	975	400	.87	0	20	1,105	490	.89	0	122	.12
Chesapeake:															
I	21409	May 23	12	14	700	358	.85	0	------	------	------	------	------	------	------
II	21408	---do----	9	21	825	334	1.37	1	------	------	------	------	------	------	------
III	21407	---do----	7	11	725	399	.60	2	16	810	440	.79	1	115	.20
CRUISE IV															
Martha's Vineyard:															
I	21431	May 28	3	17	980	340	1.09	3	20	1,150	326	1.33	2	110	.08
II	21430	May 27	24	22	990	205	2.33	3	24	1,140	228	2.28	1	128	.07
III	21429	---do----	21	19	935	365	1.13	0	23	1,030	437	1.14	0	110	.09
Montauk:															
I	21426	---do----	10	20	860	363	1.20	1	------	------	------	------	------	------	------
II	21427	---do----	13	15	960	401	.81	1	18	1,050	432	.90	1	120	.13
III	21428	---do----	17	15	885	363	.90	0	20	1,015	450	.97	0	105	.10
Shinnecock:															
I	21425	---do----	6	22	960	356	1.34	2	------	------	------	------	------	------	------
II	21424	---do----	2	16	1,000	435	.80	1	21	1,145	537	.85	0	131	.14
New York:															
I	21420	May 26	11	20	950	284	1.53	1	------	------	------	------	------	------	------
II	21421	---do----	14	14	735	254	1.20	0	17	850	322	1.15	0	100	.09
III	21422	---do----	18	17	880	367	1.01	0	21	980	442	1.03	0	130	.12
IV	21423	---do----	21	20	915	327	1.33	0	23	1,040	406	1.23	0	102	.07
Barnegat: I	21419	---do----	7	20	940	325	1.34	1	------	------	------	------	------	------	------
Atlantic City:															
I	21418	---do----	4	21	910	257	1.78	1	------	------	------	------	------	------	------
II	21417	---do----	1	11	550	161	1.48	2	18	840	159	2.46	3	116	.04
III	21416	May 25	22	20	965	355	1.22	0	23	1,075	433	1.15	0	123	.09
IV	21415	---do----	20	20	860	404	1.08	0	23	960	484	1.03	0	115	.11
Cape May:															
II	21411	---do----	7	22	970	301	1.59	0	------	------	------	------	------	------	------
III	21412	---do----	9	16	800	274	1.27	0	18	890	334	1.17	0	109	.10
IV	21413	---do----	12	18	955	285	1.37	2	22	1,080	210	2.28	3	120	.04
V	21414	---do----	14	15	940	369	.88	0	20	1,035	443	.98	0	121	.11
Chesapeake: II	21410	May 24	19	19	750	248	1.66	0	------	------	------	------	------	------	------
CRUISE V															
Montauk:															
I	21432	June 1	20	12	770	383	.68	0	16	925	454	.77	1	116	.15
II	21433	---do----	23	16	1,080	394	.88	3	20	1,255	379	1.15	2	162	.13
Shinnecock: III	21434	June 2	4	15	935	368	.89	0	20	1,080	462	.94	0	137	.12
New York:															
I	21438	---do----	20	20	915	324	1.34	1	------	------	------	------	------	------	------
II	21437	---do----	16	12	895	520	.50	1	17	985	606	.61	0	170	.29
III	21436	---do----	12	16	980	466	.75	0	21	1,080	551	.83	0	133	.14
IV	21435	---do----	9	20	915	334	1.30	0	22	1,050	419	1.14	0	122	.09
Barnegat: I	21439	June 3	1	19	815	336	1.23	1	------	------	------	------	------	------	------

TABLE 17.—*Record of oblique hauls made by 1-meter nets during cruises I to VII, inclusive, in 1932*—Continued

Cruise, locality, and haul	Station	Date	Hour	Upper net					Lower net						
				Depth (4)	Time (5)	Flow (10)	S factor (12)	Clogging (7)	Depth (4)	Time (5)	Flow (10)	S factor (12)	Clogging (7)	Time (13)	C factor (15)
CRUISE V															
Atlantic City:															
I	21440	do	5	20	885	437	0.99	0							
II	21441	do	7	13	840	425	.66	0	20	930	502	0.87	0	140	0.16
III	21442	do	10	14	985	458	.66	0	19	1,090	544	.76	0	131	.15
IV	21443	do	13	16	905	428	.81	0	21	1,005	510	.90	0	142	.15
Cape May:															
II	21447	June 4	4	17	910	171	2.16	0							
III	21446	do	1	11	690	300	.80	1	20	1,200	563	.77	0	122	.13
IV	21445	June 3	23	14	915	416	.73	0	19	1,060	519	.80	0	150	.17
V	21444	do	20	18	915	366	1.07	0	22	1,050	456	1.05	0	120	.10
Winterquarter:															
I	21448	June 4	11	18	1,050	497	.79	0							
II	21449	do	14	16	890	358	.97		20	985	396	1.10		143	.13
III	21450	do	17	15	905	450	.72	1	20	1,020	542	.80	0	135	.17
Chesapeake:															
I	21453	June 5	6	18	930	300	1.30								
II	21452	do	2	18	900	346	1.13	2							
III	21451	June 4	23	16	910	447	.78	1	20	1,025	538	.81	0	150	.18
CRUISE VI															
Martha's Vineyard:															
I	21468	June 8	7	11	725	480	.50	1	15	855	512	.64	2	97	.16
II	21467	do	4	16	845	232	1.50	2	20	975	166	2.62	3	139	.04
III	21466	do	1	18	865	403	.97	0	22	1,005	503	.95	0	142	.14
Montauk:															
I	21464	June 7	15	9	710	307	.64	2	13	805	342	.82	1	93	.16
II	21465	do	19	15	985	335	.97	2	20	1,195	282	1.54	3	131	.06
Shinnecock: II	21463	do	9	16	955	398	.87	0	20	1,105	453	.96	1	124	.11
New York:															
II	21460	June 6	21	17	905	330	1.12	2	22	1,030	368	1.30	1	124	.11
III	21461	June 7	1	18	895	218	1.80	2	22	1,000	180	2.65	2	144	.05
IV	21462	do	4	21	835	420	1.09	0	24	1,030	553	.94	0	136	.13
Atlantic City:															
I	21459	June 6	14	22	1,075	530	.90	0							
II	21458	do	11	15	855	387	.84	0	20	975	475	.92	0	132	.14
III	21457	do	9	15	950	449	.73	0	19	1,065	540	.76	0	113	.13
Cape May:															
II	21454	June 5	20	21	905	214	2.14								
III	21455	do	23	11	855	438	.55	0	15	1,015	555	.59	0	118	.19
IV	21456	June 6	2	16	855	359	.97	0	41	985	446	2.00	0	131	.06
CRUISE VII															
Martha's Vineyard:															
I	21490	June 19	16	10	890	511	.42	0	10	1,050	638	.34	0	73	.19
II	21491	do	20	16	865	496	.70	1	16	980	556	.63	1	127	.21
III	21492	do	24	17	910	473	.78	0	17	1,085	601	.61	0	104	.15
IV	21493	June 20	6	15	830	484	.67	0	16	975	602	.58	0	100	.17
Montauk:															
I	21489	June 19	10	12	725	393	.66	0	12	830	444	.59	1	86	.16
II	21488	do	6	16	895	484	.72	0	16	1,040	598	.58	0	113	.18
III	21487	do	2	15	930	523	.62	1	16	1,175	700	.50	0	141	.24
Shinnecock:															
I	21485	June 18	16	25	1,040	[1] 401	1.35								
II	21486	do	21	17	900	345	1.07	1	17	1,015	382	.97	1	121	.12
New York:															
I	21484	do	7	20	930	[1] 445	.98	0							
II	21483	do	4	14	975	275	1.11		15	1,150	324	1.01		135	.12
III	21482	June 17	23	13	860	[1] 457	.62	0	14	990	559	.54	0	128	.22
IV	21481	do	20	15	965	422	.77	0	16	1,130	532	.65	0	110	.14
Atlantic City:															
I	21469	June 15	14	15	825	[1] 411	.79	0							
II	21477	June 17	6	15	900	435	.75	1	20	1,045	498	.87	1	120	.13
III	21478	do	9	16	940	496	.70	0	20	1,050	590	.74	0	149	.18
IV	21479	do	12	21	925	356	1.28	0	24	1,035	434	1.20	0	135	.10
Cape May:															
III	21476	June 16	23	16	960	438	.79	0	20	1,080	530	.82	0	192	.19
IV	21475	do	20	13	820	388	.73		18	930	440	.89		154	.12
V	21474	do	18	14	830	365	.83	0	19	925	438	.94	0		
Winterquarter:															
I	21471	do	5	17	750	[1] 242	1.53	2	22	990	507	.94	0		
II	21472	do	8	18	895	428	.91	0							

TABLE 18.—*Record of oblique hauls made with a 2-meter net during cruises VIII and IX, 1932*

Locality	Station	Date	Hour	Depth (4)	Time (5)	Flow (10)	S Factor (12)
CRUISE VIII							
Martha's Vineyard:							
I	1283	July 1	20	28	1,440	1,128	0.135
II	1282	---do---	16	27	1,500	1,075	.135
Montauk:							
I	1276	June 30	7	21	1,620	2,349	.048
IV	1259	June 25	11	28	1,740	1,131	.135
Shinnecock:							
I	1275	June 29	13	26	1,260	987	.141
II	1274	---do---	18	34	1,620	729	.256
New York:							
I	1270	June 28	21	29	1,440	1,128	.137
II	1271	June 29	2	25	1,440	1,536	.088
III	1272	---do---	7	24	1,440	1,728	.074
V	1260	June 26	2	21	1,740	2,526	.043
VI	1261	---do---	4	25	1,440	1,632	.083
Barnegat: I	1269	June 28	16	17	960	704	.131
Atlantic City:							
I	1262	June 26	20	14	780	572	.131
II	1263	---do---	24	39	1,680	812	.256
III	1264	June 27	4	34	1,500	725	.256
IV	1265	---do---	7	34	1,380	667	.268
Cape May:							
II	1266	---do---	18	22	1,260	987	.119
III	1267	---do---	21	33	1,560	884	.196
IV	1268	---do---	24	25	1,560	1,664	.080
CRUISE IX							
Cape Ann: II	1319	July 23	5	43	2,460	2,050	.112
Boston: II	1318	July 22	13	27	1,260	504	.282
Cape Cod Bay: I	1316	---do---	17	31	1,800	1,440	.114
Race Point: I	1315	---do---	13	31	1,920	1,152	.145
Chatham: II	1328	July 24	23	40	1,740	841	.256
Western Georges: III	1308	July 21	8	63	1,980	1,551	.214
South Channel: IV	1307	---do---	4	72	1,680	588	.680
Martha's Vineyard:							
I	1303	July 20	6	39	2,280	1,900	.110
II	1302	---do---	1	49	1,620	1,053	.256
Montauk:							
I	1288	July 16	13	18	960	960	.101
III	1290	July 17	10	38	1,800	1,080	.194
Shinnecock: I	1294	July 18	3	18	1,500	1,925	.050
New York: II	1296	---do---	16	23	1,380	1,021	.122

NOTE:—The above table does not include hauls failing to take mackerel larvae. For a list of these see foot of table 19 and table 20.

RECORDS OF TOW NETTING AND CATCHES OF 1932

Since the methods of reducing catches of eggs and larvae to the standard basis on which the conclusions of this paper rest, are, to a considerable extent, novel, and therefore have not stood the test of usage, and since techniques may be altered in the future in such a way as to require recalculation of present results to provide material for comparison, there are given in tables 17 to 20, inclusive, the more pertinent of the records of the cruises of 1932.

Tables 17 and 18 give the conditions under which the hauls were made, and the relation of the data to each other may be understood by consulting table 15. Similarly, tables 19 and 20, giving the counts of examined portions of catches and the standardized total catches, were based on computations illustrated by table 14.

Since the data on hydrographic conditions have already been published (Bigelow, 1933, pp. 124–128 and 131–133) they are omitted from this paper.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*

[Numbers following the locality designation are the serial numbers of the stations. Numbers in parenthesis are the fractions of the haul sorted for eggs and larvae. The entire haul was sorted for large larvae. The numbers given in the table are the actual counts in the sorted fractions; numbers given on the adjusted total lines are these counts converted to total catch and adjusted to represent the number per 17.07 square meter of sea surface]

CRUISE I

Item	Number of eggs by stages			Number of larvae by millimeter classes						
	A	B	C	3	4	5	6	7	8	9
New York II 21335:										
Upper haul:										
Eggs and larvae (0.0250)	179	4								
Lower haul:										
Eggs and larvae (0.0250)	43	3								
Adjusted total	5,806	206								
New York III 21334:										
Upper haul:										
Eggs and larvae (0.0500)	19	15	2							
Lower haul:										
Eggs and larvae (0.0500)	9	10	1							
Adjusted total	344	314	37							
New York IV 21333:										
Upper haul:										
Eggs and larvae (0.0100)	8	3	1							
Lower haul:										
Eggs and larvae (0.2000)	6									
Adjusted total	66	17	5							
New York V 21332 [1]:										
Upper haul:										
Eggs and larvae (0.1000)		1								
Adjusted total		6								
Barnegat I 21336:										
Upper haul:										
Eggs and larvae (0.1000)	18									
Adjusted total	254									
Atlantic City I 21337:										
Upper haul:										
Eggs and larvae (0.1000)	9	1								
Adjusted total	105	12								
Atlantic City II 21338:										
Upper haul:										
Eggs and larvae (0.0600)	31	4	1							
Lower haul:										
Eggs and larvae (0.0500)	3									
Adjusted total	621	72	18							
Atlantic City III 21339:										
Upper haul:										
Eggs and larvae (0.0500)	10	47	14	1						
Lower haul:										
Eggs and larvae (0.0500)		13	1							
Adjusted total	194	1,189	291	19						
Atlantic City IV 21340:										
Upper haul:										
Eggs and larvae (0.0500)	1	49	12							
Lower haul:										
Eggs and larvae (0.0500)		19	2							
Adjusted total	19	1,388	278							
Cape May II 21345:										
Upper haul:										
Eggs and larvae (0.0500)	177	26	10	3						
Adjusted total	3,503	515	198	59						
Cape May III 21344:										
Upper haul:										
Eggs and larvae (0.1070)	32	220	134	30						
Lower haul:										
Eggs and larvae (0.1000)	22	80	37	13						
Adjusted total	491	2,635	1,485	381						

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE I—Continued

Item	Number of eggs by stages			Number of larvae by millimeter classes						
	A	B	C	3	4	5	6	7	8	9
Cape May IV 21343:										
Upper haul:										
Eggs and larvae (0.1000)		43	59	2						
Lower haul:										
Eggs and larvae (0.1070)		9	18	1						
Adjusted total		541	830	34						
Cape May V 21343:										
Upper haul:										
Eggs and larvae (0.0500)		29	38	42						
Lower haul:										
Eggs and larvae (0.0500)		3	7	1						
Adjusted total		706	991	955						
Fenwick I 21346:										
Upper haul:										
Eggs and larvae (0.1000)	1	20	6	12						
Adjusted total	12	250	75	150						
Winterquarter I 21347:										
Upper haul:										
Eggs and larvae (0.0533)		2	2	55						
Adjusted total		44	44	1,197						
Winterquarter II 21348:										
Upper haul:										
Eggs and larvae (0.0867)			28	25	30	3				
Large larvae						1	3	1		
Lower haul:										
Eggs and larvae (0.1333)			7	1	4	2	1			
Adjusted total			294	224	289	42	11	1		
Winterquarter III 21349:										
Upper haul:										
Eggs and larvae (0.0533)			5	49	66	6				
Large larvae						7	4	9	3	1
Lower haul:										
Eggs and larvae (0.1300)			3	5	9	4				
Large larvae								1		
Adjusted total			121	993	1,355	149	4	11	4	1
Chesapeake I 21352:										
Upper haul:										
Eggs and larvae (0.3000)				1	4	7	2			
Adjusted total				5	20	35	10			
Chesapeake II 21351:										
Upper haul:										
Eggs and larvae (0.3333)					8	4	4			
Adjusted total					26	13	13			
Grand adjusted total	11,415	7,895	4,667	4,017	1,690	239	38	12	4	1

CRUISE II

Martha's Vineyard I 21381: [3]										
Upper haul:										
Eggs (0.0187) larvae (0.0373)	4									
Adjusted total	246									
Montauk I 21375:										
Upper haul:										
Eggs (0.0280) larvae (0.0560)	25									
Adjusted total	1,170									
Montauk II 21376: [4]										
Upper haul:										
Eggs and larvae (0.0560)	1									
Adjusted total	18									

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE II—Continued

Item	Number of eggs by stages			Number of larvae by millimeter classes						
	A	B	C	3	4	5	6	7	8	9
Shinnecock I 21374: [1]										
Upper haul:										
Eggs (0.0280) larvae (0.1120)	66	6								
Adjusted total	2,662	242								
Shinnecock II 21373:										
Upper haul:										
Eggs and larvae (0.0560)	5	6								
Adjusted total	56	68								
New York I 21369:										
Upper haul:										
Eggs (0.0187) larvae (0.0373)	22	162	182							
Adjusted total	1,157	8,510	9,560							
New York II 21370:										
Upper haul:										
Eggs (0.0124) larvae (0.0248)	76	14	3	4						
Lower haul:										
Larvae (0.0448)				9						
Adjusted total	5,802	1,068	229	342						
New York III 21371: [1]										
Upper haul:										
Eggs and larvae (0.0560)	2		3							
Adjusted total	42		63							
Barnegat I 21368:										
Upper haul:										
Eggs and larvae (0.0280)	191	40	71	61						
Adjusted total	9,420	1,972	3,500	3,010						
Atlantic City I 21367:										
Upper haul:										
Eggs (0.0187) larvae (0.0373)	15	23	23	5						
Adjusted total	965	1,480	1,480	161						
Atlantic City II 21366:										
Upper haul:										
Eggs and larvae (0.0560)	1	3	9	7						
Adjusted total	25	75	225	175						
Atlantic City III 21365: [2]										
Upper haul:										
Eggs and larvae (0.0373)		2	2							
Large larvae								1		
Adjusted total		50	50					1		
Atlantic City IV 21364: [2]										
Upper haul:										
Eggs and larvae (0.0373)			2							
Adjusted total			43							
Cape May I 21359:										
Upper haul:										
Eggs and larvae (0.0560)			3	2						
Adjusted total			68	45						
Cape May II 21360:										
Upper haul:										
Eggs (0.0280) larvae (0.0560)			74	21						
Adjusted total			2,665	379						
Cape May III 21361:										
Upper haul:										
Eggs and larvae (0.0560)		4	5	1						
Adjusted total		120	150	30						

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE II—Continued

Item	Number of eggs by stages			Number of larvae by millimeter classes						
	A	B	C	3	4	5	6	7	8	9
Cape May IV 21362:										
Upper haul:										
Eggs and larvae (0.0560)			1	23	1					
Lower haul:										
Larvae (0.0560)					1					
Adjusted total			22	463	42					
Cape May V 21363: [1]										
Upper haul:										
Eggs and larvae (0.0560)					1					
Adjusted total					1					
Winterquarter I 21358:										
Upper haul:										
Eggs and larvae (0.0373)			2	17						
Large larvae					2	1				
Adjusted total			121	1,030	5	2				
Winterquarter II 21357:										
Upper haul:										
Eggs and larvae (0.0373)			2	26	13	6				
Large larvae						2	3			
Lower haul:										
Larvae (0.0373)			9	2	5	2				
Large larvae						1	1			
Adjusted total			52	675	520	227	5			
Winterquarter III 21356:										
Upper haul:										
Eggs and larvae (0.0560)						2	5			
Large larvae							4	2		
Lower haul: [2]										
Large larvae							3	6		
Adjusted total						43	111	12		
Chesapeake I 21353:										
Upper haul:										
Eggs and larvae (0.0560)						3	1			
Large larvae								1		
Adjusted total						55	18	1		
Chesapeake II 21354:										
Upper haul:										
Eggs and larvae (0.0373)					9	14	6			
Large larvae						3	4	3	2	1
Adjusted total					270	420	174	3	2	1
Chesapeake III 21355: [3]										
Upper haul: [4]										
Large larvae						3	2	3		
Adjusted total						4	3	4		
Grand adjusted total	21,563	13,585	18,228	6,310	838	751	311	21	2	1

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE III

Item	Number of eggs by stages			Number of larvae by millimeter classes								
	A	B	C	3	4	5	6	7	8	9	10	11
Martha's Vineyard I 21382: [1]												
Upper haul:												
Eggs (0.0280) larvae (0.0560)	81											
Adjusted total	2,060											
Montauk I 21387: [3]												
Upper haul:												
Eggs (0.0187) larvae (0.0373)	88	25										
Adjusted total	3,774	1,072										
Montauk II 21386: [2]												
Upper haul:												
Eggs and larvae (0.0560)	3	3										
Adjusted total	74	74										
Shinnecock I 21388:												
Upper haul:												
Eggs (0.0224) larvae (0.0448)	327	95	25	2								
Adjusted total	15,470	4,500	1,183	47								
Shinnecock II 21389: [1]												
Upper haul:												
Eggs and larvae (0.0560)	1	12	5									
Adjusted total	20	240	100									
New York I 21393:												
Upper haul:												
Eggs (0.0224) larvae (0.0448)	16	84	6	13								
Lower haul:												
Larvae (0.0373)				1								
Adjusted total	786	4,130	295	312								
New York II 21392:												
Upper haul:												
Eggs (0.0224) larvae (0.0448)	3	30	21	24								
Lower haul:												
Larvae (0.0373)				2								
Adjusted total	94	940	658	363								
New York III 21391: [2]												
Upper haul:												
Eggs and larvae (0.0373)		2	5	1								
Adjusted total		40	99	17								
New York IV 21390: [1]												
Upper haul:												
Eggs and larvae (0.0373)		2	1									
Large larvae									1			
Adjusted total		51	25						1			
Barnegat I 21394:												
Upper haul:												
Eggs and larvae (0.0280)		18	9	38	2							
Adjusted total		1,479	739	3,120	164							
Atlantic City I 21395:												
Upper haul:												
Eggs and larvae (0.0448)		10	1	10	3							
Adjusted total		286	29	286	86							
Atlantic City II 21396:												
Upper haul:												
Eggs and larvae (0.0373)		4	27	58	9							
Large larvae					1							
Lower haul:												
Larvae (0.0448)				6	2							
Adjusted total		160	1,070	2,250	383							
Atlantic City III 21397: [3]												
Upper haul:												
Eggs and larvae (0.0373)		2	3	2								
Adjusted total		72	109	66								

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE III—Continued

Item	Number of eggs by stages			Number of larvae by millimeter classes								
	A	B	C	3	4	5	6	7	8	9	10	11
Atlantic City IV 21398:[3]												
Upper haul:												
Eggs and larvae (0.0840)		2	1									
Adjusted total		21	11									
Cape May II 21402:												
Upper haul:												
Eggs and larvae (0.0747)	1	28	46	2	21	19	3					
Large larvae							9					
Adjusted total	16	454	746	32	341	308	49					
Cape May III 21401:												
Upper haul:												
Eggs and larvae (0.0373)			7	17	1							
Large larvae				1		2						
Lower haul:												
Larvae (0.0448)				1								
Adjusted total			202	470	25	2						
Cape May IV 21400:[3]												
Upper haul:												
Eggs and larvae (0.0747)				25	20	3						
Large larvae					4	26	4					
Adjusted total				362	289	39	5					
Cape May V 21399:[5]												
Lower haul:												
Larvae (0.0560)				1								
Adjusted total				13								
Fenwick I 21403:												
Upper haul:												
Eggs and larvae (0.0560)					21	7	3					
Large larvae							24	15	2			
Adjusted total					495	165	47	20	3			
Winterquarter I 21404:												
Upper haul:												
Eggs and larvae (0.1000)					34	81	41	10	1			
Large larvae						2	6	16	7			
Adjusted total					268	640	324	79	7			
Winterquarter II 21405:												
Upper haul:												
Eggs and larvae (0.1000)					11	30	5	1				
Large larvae						1	9	5	2			
Adjusted total					148	402	67	10	3			
Winterquarter III 21406:[3]												
Upper haul:												
Eggs (0.1000) larvae (1.0000)					10	50	52	15	7	1		1
Adjusted total					8	39	40	11	5	1		1
Chesapeake I 21409:[6]												
Upper haul:												
Large larvae								3				
Adjusted total								3				
Chesapeake II 21408:												
Upper haul:												
Eggs and larvae (0.1000)						1	2	5			1	
Large larvae						7	11	14	15	10	3	3
Adjusted total						11	18	26	21	14	5	4
Chesapeake III 21407:												
Upper haul:												
Eggs and larvae (0.1000)							1				1	
Large larvae						1	5	2	1	1		
Lower haul:												
Larvae (0.0448)							1	1				
Large larvae										1	1	
Adjusted total						1	4	2	1	2	2	
Grand adjusted total	22, 294	13, 519	5, 266	7, 338	2, 207	1, 607	554	151	40	18	7	5

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE IV

Item	Number of eggs by stages			Number of larvae by millimeter classes								
	A	B	C	3	4	5	6	7	8	9	10	11
Martha's Vineyard I 21431: [7]												
Upper haul:												
Eggs (0.0187) larvae (0.0373)	27	88	131	28								
Adjusted total	1,574	5,140	7,650	753								
Martha's Vineyard II 21430:												
Upper haul:												
Eggs and larvae (0.0373)	8	18	12	10								
Lower haul:												
Larvae (0.0560)				11								
Adjusted total	499	1,122	748	972								
Martha's Vineyard III 21429: [1]												
Upper haul:												
Eggs and larvae (0.0560)	14	14	2									
Adjusted total	283	282	40									
Montauk I 21426:												
Upper haul:												
Eggs (0.0280) larvae (0.0560)	103	16	15	15								
Adjusted total	4,416	686	643	322								
Montauk II 21427:												
Upper haul:												
Eggs and larvae (0.0224)	1	8	57	68								
Lower haul:												
Larvae (0.0448)				3								
Adjusted total	36	289	2,061	2,203								
Montauk III 21428: [1]												
Upper haul:												
Eggs and larvae (0.0560)	1		15	24								
Adjusted total	16		241	347								
Shinnecock I 21425:												
Upper haul:												
Eggs and larvae (0.0187)	55	75	64	40	2							
Adjusted total	3,953	5,380	4,600	2,875	144							
Shinnecock II 21424:												
Upper haul:												
Eggs and larvae (0.0224)	8	2	23	52								
Lower haul:												
Larvae (0.0560)				9								
Adjusted total	285	71	820	1,754								
New York I 21420:												
Upper haul:												
Eggs and larvae (0.0373)		1										
Adjusted total		41										
New York II 21421:												
Upper haul:												
Eggs and larvae (0.0280)	7	27	108	149	51							
Lower haul:												
Larvae (0.0373)				37	19	1						
Adjusted total	300	1,155	4,630	6,861	2,549	31						
New York III 21422:												
Upper haul:												
Eggs and larvae (0.0373)	5	2	1	22	1							
Lower haul:												
Larvae (0.0448)				1								
Adjusted total	135	54	27	546	24							
New York IV 21423: [1]												
Upper haul:												
Eggs and larvae (0.0448)	19	1		3								
Adjusted total	563	30		83								

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE IV—Continued

Item	Number of eggs by stages			Number of larvae by millimeter classes								
	A	B	C	3	4	5	6	7	8	9	10	11
Barnegat I 21419:												
Upper haul:												
Eggs (0.0187) larvae (0.0373)		1	1	1	1							
Adjusted total		36	36	72	72							
Atlantic City I 21418:												
Upper haul:												
Eggs and larvae (0.0373)				8	10	12	2					
Large larvae						2	8					
Adjusted total				382	477	573	95					
Atlantic City II 21417:												
Upper haul:												
Eggs and larvae (0.0373)	2	2		7	2							
Large larvae						1						
Lower haul:												
Larvae (0.0560)				13	15							
Adjusted total	80	79		820	731	1						
Atlantic City III 21416: [1]												
Upper haul:												
Eggs and larvae (0.0747)	2		1	4								
Adjusted total	32		16	60								
Atlantic City IV 21415: [2]												
Upper haul:												
Eggs and larvae (0.1120)			1				1					
Large larvae								2				
Adjusted total			10				1	2				
Cape May II 21411:												
Upper haul:												
Eggs and larvae (0.0448)		26	2		2	1	2					
Large larvae							5	1				
Adjusted total		922	71		71	36	70	1				
Cape May III 21412:												
Upper haul:												
Eggs and larvae (0.0747)			7	15	15	7	2					
Large larvae						6	14	2				
Lower haul:												
Larvae (0.0560)				1	1							
Adjusted total			119	247	247	107	31	2				
Cape May IV 21413:												
Upper haul:												
Eggs and larvae (0.0896)				6	10							
Lower haul: [3]												
Large larvae								1				
Adjusted total				88	147			2				
Cape May V 21414: [1]												
Upper haul:												
Eggs and larvae (0.1120)				1								
Adjusted total				7								
Chesapeake II 21410:												
Upper haul:												
Eggs and larvae (0.0896)								1	1		2	
Large larvae						2	2	10	28	17		1
Adjusted total						3	3	18	48	28	3	2
Grand adjusted total	12,172	15,287	21,712	18,392	4,462	751	200	25	48	28	3	2

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE V

Item	Number of eggs by stages			Number of larvae by millimeter classes											
	A	B	C	3	4	5	6	7	8	9	10	11	12	13	14
Montauk I 21432:															
Upper haul:															
Eggs (0.0187) larvae (0.0373)	40	5	1	5											
Lower haul:															
Larvae (0.1056)				2											
Adjusted total	1,456	182	36	95											
Montauk II 21433:															
Upper haul:															
Eggs and larvae (0.0280)	6	10	160	158											
Lower haul:															
Larvae (0.0896)				31											
Adjusted total	188	314	5,030	4,665											
Shinnecock III 21434:															
Upper haul:															
Eggs and larvae (0.0448)	5	8	4	12	29	17									
Lower haul:															
Larvae (0.0896)				4	6	4									
Adjusted total	99	159	79	253	574	342									
New York I 21438:															
Upper haul:															
Eggs and larvae (0.0373)			4				5	1							
Large larvae								19	1						
Adjusted total			144				180	35	1						
New York II 21437:															
Upper haul:															
Eggs (0.0187) larvae (0.0373)	29	37	21	2	6	5	11	4	2						
Large larvae								1	12	2					
Lower haul:															
Larvae (0.0373)				2	9	6	3								
Large larvae						1	16	3							
Adjusted total	776	990	563	55	214	154	168	41	18	1					
New York III 21436:															
Upper haul:															
Eggs and larvae (0.0672)	11	14	6	11	12	8									
Large larvae							6								
Lower haul:															
Larvae (0.0747)					1	5									
Large larvae					1	5	2								
Adjusted total	123	156	67	105	128	129	5								
New York IV 21435:															
Upper haul:															
Eggs and larvae (0.1120)	19	22	1	1	16	6									
Lower haul:															
Larvae (0.0896)				1											
Adjusted total	221	256	12	23	169	64									
Barnegat I 12439:															
Upper haul:															
Eggs and larvae (0.0747)					1	9	19	20							
Large larvae								18	10						
Adjusted total					16	148	312	317	12						
Atlantic City I 21440:															
Upper haul:															
Eggs and larvae (0.0896)	4			1			2	2							
Large larvae									2	2					
Adjusted total	44			11			22	18	2	2					
Atlantic City II 21441:															
Upper haul:															
Eggs (0.0280) larvae (0.1120)			2		1		6	10							
Large larvae								1	2						
Lower haul:															
Larvae (0.0896)					2	8	2		12						
Large larvae						11	8	11	6	1					
Adjusted total			47		24	78	38	59	7	1					

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE V—Continued

Item	Number of eggs by stages			Number of larvae by millimeter classes											
	A	B	C	3	4	5	6	7	8	9	10	11	12	13	14
Atlantic City III 21442:															
Upper haul:															
Eggs and larvae (0.0896)			3		3	7	50	44	6						
Large larvae							1								
Lower haul:															
Larvae (0.0560)					5		1								
Large larvae				1	9	15	32	15	4						
Adjusted total			22	1	96	57	346	290	41						
Atlantic City IV 21443:															
Upper haul:															
Eggs and larvae (0.0747)			1	1	1										
Large larvae				1	13										
Lower haul:															
Larvae (0.0747)					1	2									
Large larvae						1									
Adjusted total			11	7	22	20									
Cape May II 21447:															
Upper haul:															
Eggs and larvae (0.0747)						1	1		1					1	
Large larvae							1					2	1		
Adjusted total						29	29		1			2	1	1	
Cape May III 21446:															
Upper haul:															
Eggs and larvae (0.0747)						1	1	4							
Large larvae								1	2		4	2			
Lower haul:															
Larvae (0.0373)										1					
Large larvae								2	1	1					
Adjusted total						10	10	32	3	2	3	2			
Cape May IV 21445:															
Upper haul:															
Eggs and larvae (0.0747)						2	2	11	11	4					
Large larvae										7					
Lower haul:															
Larvae (0.0960)								4	4						
Large larvae							6	15	11	6					
Adjusted total						17	22	108	104	38					
Cape May V 21444: [8]															
Upper haul:															
Large larvae								1							
Lower haul: [9]															
Large larvae						1									
Adjusted total						1		1							
Winterquarter I 21448: [10]															
Upper haul:															
Large larvae								5		2					1
Adjusted total								4		2					1
Winterquarter II 21449: [11]															
Upper haul:															
Large larvae								1				1	1		1
Adjusted total								1				1	1		1
Winterquarter III 21450:															
Upper haul: [8]															
Large larvae									2	4	1				
Lower haul: [9]															
Larvae (0.0112)										1					
Large larvae									1	2					
Adjusted total									2	5	1				
Chesapeake III 21451:															
Upper haul:									1		1				
Eggs and larvae (0.0747)								7	10	5	3				
Large larvae															
Lower haul:									1		1				
Larvae (0.1120)								1	1			1			
Large larvae															
Adjusted total								5	9	3	3	1			
Grand adjusted total	2,907	2,057	6,011	5,215	1,243	1,049	1,132	911	200	54	7	6	2	1	2

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE VI

Locality	Number of eggs by stages			Number of larvae by millimeter classes												
	A	B	C	3	4	5	6	7	8	9	10	11	12	13	14	15
Martha's Vineyard I 21468:																
Upper haul:																
Eggs and larvae (0.0187)	77	28	20	10	5	7										
Large larvae					12	13	4									
Lower haul:																
Larvae (0.0373)				1	1	1										
Large larvae						1										
Adjusted total	2,062	751	536	251	138	184	2									
Martha's Vineyard II 21467:																
Upper haul:																
Eggs (0.0373) larvae (0.0224)			2	21	40	16	2									
Large larvae				1	1	34	60	24	1							
Lower haul:																
Larvae (0.0373)				6	4	2										
Large larvae					5	22	6	5								
Adjusted total			80	1,934	3,198	1,278	119	46	2							
Martha's Vineyard III 21466:																
Upper haul:																
Eggs (0.0448) larvae (0.0224)				42	81	10		1								
Large larvae					1	3										
Lower haul:																
Larvae (0.0672)				17	23	1										
Large larvae				1	10	4										
Adjusted total				1,822	3,366	388		1								
Montauk I 21464:																
Upper haul:																
Eggs (0.0187) larvae (0.0373)	22	5	1	19	4											
Large larvae						5	13									
Lower haul:																
Larvae (0.0672)				31	24	9	1									
Large larvae						5	14									
Adjusted total	753	171	34	663	343	113	19									
Montauk II 21465:																
Upper haul:																
Eggs (0.0448) larvae (0.0224)		3	21	75	11	1										
Large larvae				2	4	24	4		1							
Lower haul:																
Larvae (0.0747)				6	3	1										
Large larvae						1										
Adjusted total		65	455	3,145	495	58	4		1							
Shinnecock II 21463:																
Upper haul:																
Eggs and larvae (0.0560)		1	13	46	22	2										
Large larvae				1	1	17	34	9								
Lower haul:																
Larvae (0.0896)				4	3		1									
Adjusted total		16	202	682	319	14	38	7								
New York II 21460:																
Upper haul:																
Eggs and larvae (0.0448)		1	1	1	2	2	3	8	13	2						
Large larvae									41	83	10					
Lower haul:																
Larvae (0.0896)						3	1		3	5						
Large larvae					1	11	3	13	34	15	3	1				
Adjusted total		25	25	22	45	84	79	191	280	106	14	1				
New York III 21461:																
Upper haul:																
Eggs and larvae (0.0373)		2	1	13	3	1										
Large larvae					1	21	14	9	2							
Lower haul:																
Larvae (0.0747)				1	4	2										
Large larvae						8	3	1								
Adjusted total		97	48	611	237	88	30	16	4							

See footnotes at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE VI—Continued

Locality	Number of eggs by stages			Number of larvae by millimeter classes												
	A	B	C	3	4	5	6	7	8	9	10	11	12	13	14	15
New York IV 21462:																
Upper haul:																
Eggs and larvae (0.0896)		3	15	8	1		12	1								
Large larvae								21	4							
Lower haul:																
Larvae (0.0407)					3	2										
Large larvae						10	13	8								
Adjusted total		36	182	84	66	28	127	28	3							
Atlantic City I 21459:																
Upper haul:																
Eggs and larvae (0.0560)											1					
Large larvae						1	2	1	3	13	13	1				
Adjusted total						1	2	1	3	12	13	1				
Atlantic City II 21458:																
Upper haul:																
Eggs and larvae (0.1120)								7	14							
Large larvae						1	5	41	84	6						
Lower haul:																
Larvae (0.0747)					1	8	4	2	4							
Large larvae					5	33	42	35	30	15	1	1				
Adjusted total					12	99	45	69	99	18	1	1				
Atlantic City III 21457:																
Upper haul:																
Eggs (0.0747), larvae (0.1120)					1			1	16	1						
Large larvae					4	11	14	20	65	31	1					
Lower haul:																
Larvae (0.0560)					1	3	1	1								
Large larvae					2	32	23	15	7	7						
Adjusted total					17	34	27	26	66	26	1					
Cape May II 21454:																
Upper haul:																
Eggs and larvae (0.0560)										1						
Adjusted total										2						
Cape May III 21455:																
Upper haul:																
Eggs and larvae (0.0560)							1				1			1	1	
Large larvae						2	8	12	1	10	4	11	3	2	3	1
Lower haul:[12]																
Large larvae									1	1	2	1		1		
Adjusted total						1	4	6	2	6	4	6	2	3	2	1
Cape May IV 21456:																
Upper haul:																
Eggs and larvae (0.0560)								1		1						
Large larvae						1	5	7	10	11	6	3	2	1		
Lower haul:																
Larvae (0.0560)											1					
Large larvae									1	3						
Adjusted total						1	5	8	10	16	8	3	2	1		
Grand adjusted total	2,815	1,161	1,562	9,214	8,236	2,371	501	399	470	186	41	12	4	4	2	1

See footnote at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE VII

Locality	Number of eggs by stages			Number of larvae by millimeter classes																		
	A	B	C	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Martha's Vineyard I 21490:																							
Upper haul:																							
Eggs and larvae (0.0224)	31	48	44	192	1		1																
Large larvae					3	8	12	7	6	1													
Lower haul:																							
Larvae (0.0560)				12		1																	
Large larvae								2	2														
Adjusted total	583	901	827	3,135	15	11	4	3	3	1													
Martha's Vineyard II 21491:																							
Upper haul:																							
Eggs (0.0140) larvae (0.0560)			2	27	12	15	11	2															
Large larvae							10	20	6														
Lower haul:																							
Larvae (0.0747)				8	4	6	1	1															
Large larvae						1	2	3															
Adjusted total			100	361	164	214	122	27	3														
Montauk I 21489:																							
Upper haul:																							
Eggs and larvae (0.0200)	6	7	21	32	3	3																	
Large larvae					2	12	5	7	2														
Lower haul:																							
Larvae (0.0167)				36	7	3	1																
Large larvae					1	2	7	6	1														
Adjusted total	198	231	693	2,230	337	186	35	8	3														
Montauk II 21488:																							
Upper haul:																							
Eggs and larvae (0.0896)									2		1												
Large larvae							1	4	6	7	3	1	1										
Lower haul:																							
Larvae (0.1120)						1			1	2			1										
Large larvae						1	4		2	7	6	2	2										
Adjusted total						1	3	2	7	10	6	2	3										
Montauk III 21487:																							
Upper haul:																							
Eggs and larvae (0.0747)														1									
Large larvae										2	4	5	7	4	3				1				
Lower haul:																							
Larvae (0.0747)						1																	
Large larvae								2	1			1	3	1									
Adjusted total								1		1	2	3	5	3	2				1				
Shinnecock I 21485:																							
Upper haul:																							
Eggs and larvae (0.0267)		2	13	59	4	2																	
Large larvae				2	5	10	14	2															
Adjusted total		101	658	2,985	202	78	20	3															
Shinnecock II 21486:																							
Upper haul: [13]																							
Large larvae					1	3	3							1	6	2		2	5	3	1	1	1
Lower haul: [14]																							
Large larvae					2	2	1	1									2						
Adjusted total					3	5	4	1						1	5	2	2	2	4	3	1	1	1
New York I 21484:																							
Upper haul:																							
Eggs (0.0280) larvae (0.0560)	2	2	13	4																			
Large larvae								1															
Adjusted total	70	70	455	70				1															
New York II 21483:																							
Upper haul:																							
Eggs and larvae (0.1120)					2																		
Large larvae					4	6	3		1														
Lower haul:																							
Larvae (0.0747)							1																
Large larvae					1	1	2									1							
Adjusted total					7	7	6		1							1							

See footnote at end of table.

TABLE 19.—*Record of mackerel eggs and larvae caught during cruises I to VII in 1932*—Continued

CRUISE VII—Continued

Locality	Number of eggs by stages			Number of larvae by millimeter classes																	
	A	B	C	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
New York III 21482:																							
Upper haul:																							
Eggs and larvae (0.1667)													1	1									
Large larvae						1							1	4	1	1							
Lower haul:																							
Larvae (0.2500)					3	17	3																
Large larvae						2	6	1															
Adjusted total					6	38	5	1					1	2	1	1							
New York IV 21481:																							
Upper haul:																							
Eggs and larvae (0.2000)						2	1																
Large larvae						2	3	3			1												
Lower haul:																							
Larvae (0.0500)								1															
Large larvae							1	1															
Adjusted total						3	4	3			1												
Atlantic City I 21469:																							
Upper haul:																							
Eggs and larvae (0.0667)				2																			
Large larvae														1									
Adjusted total				24										1									
Atlantic City II 21477: [15]																							
Lower haul:																							
Large larvae [16]																		1					
Adjusted total																		1					
Atlantic City III 21478: [17]																							
Lower haul: [18]																							
Large larvae									1														
Adjusted total									1														
Atlantic City IV 21479: [19]																							
Upper haul:																							
Large larvae									1														
Adjusted total									1														
Cape May IV 21475:																							
Upper haul:																							
Large larvae [8]						1	2	2			1												
Lower haul:																							
Large larvae [1]										1						1							
Adjusted total [20]						3	5	5		1	3					1							
Grand adjusted total	851	1,303	2,733	8,805	734	546	208	55	19	13	12	5	9	7	8	5	2	3	5	3	1	1	1

NOTE.—The above given table does not include stations at which hauls were made and no eggs or larvae of mackerel found. All these hauls were completely sorted for large larvae, but only fractions for eggs and small larvae. In the following enumeration that includes all such stations, the fractions of hauls sorted are included in parentheses, and the letters U and L refer to upper and lower hauls, respectively. Unless otherwise specified, the fraction given for upper haul was sorted for both eggs and larvae, those of the lower haul for larvae only. Cruise I: Martha's Vineyard I 21327 (U 0.0187 for eggs) (0.0747 for larvae); Martha's Vineyard II 21328 (U 0.0747) (L 0.0747); Martha's Vineyard III 21329 (U 0.0747) (L 0.0560); Martha's Vineyard IV 21330 (U 0.0747) (L 0.0560); New York VI 21331 (U 0.1120) (L 0.0747); Cape May VI 21341 (U 0.0500); Chesapeake III 21350 (U 0.2500) (L 0.1000). Cruise II: Martha's Vineyard II 21380 (U 0.0373) (L 0.0560); Martha's Vineyard III 21379 (U 0.2800 for eggs) (0.0560 for larvae) (L 0.0323); Montauk III 21377 (U 0.0373) (L 0.0373); New York IV 21372 (U 0.0560) (L 0.0747). Cruise III: Martha's Vineyard II 21383 (U 0.0560) (L 0.0560); Martha's Vineyard III 21384 (U 0.0373) (L 0.0448); Montauk III 21385 (U 0.0560) (L 0.0448). Cruise V: Chesapeake I 21453 (U 0.0187 for eggs) (0.0373 for larvae); Chesapeake II 21452 (U 0.0560). Cruise VII: Martha's Vineyard III 21492 (U 0.0373) (L 0.0747); Martha's Vineyard IV 21493 (U 0.1120) (L 0.0896); Cape May II 21470 (U 0.0373); Cape May III 21476 (U 0.2000) (L 0.2000); Cape May V 21474 (U 1.0000) (L 1.0000); Winterquarter I 21471 (U 0.0373 for eggs) (0.0187 for larvae); Winterquarter II 21472 (U 0.0448 for eggs) (0.0224 for larvae) (L 0.0896).

[1] No larvae found in 0.0560 of lower haul.
[2] No larvae found in 0.0448 of lower haul.
[3] No larvae found in 0.0373 of lower haul.
[4] No larvae found in 0.0373 of upper haul.
[5] No eggs or larvae found in 0.0747 of upper haul.
[6] No eggs or larvae found in 0.0250 of upper haul.
[7] No larvae found in 0.0320 of lower haul.
[8] No eggs or larvae found in 0.0407 of upper haul.
[9] No larvae found in 0.1120 of lower haul.
[10] No eggs found in 0.0448 of upper haul or larvae in 0.0224 of upper haul.
[11] No eggs or larvae found in 0.0747 of upper haul and no larvae in 0.0747 of lower haul.
[12] No larvae found in 0.0280 of lower haul.
[13] No eggs or larvae found in 0.1120 of upper haul.
[14] No larvae found in 0.0747 of lower haul.
[15] No eggs or larvae found in 0.1120 and no large larvae in entire upper haul.
[16] No small larvae found in 0.1667 of lower haul.
[17] No eggs or larvae found in 0.1000 of upper haul and no large larvae in entire upper haul.
[18] No larvae found in 0.2000 of lower haul.
[19] No eggs or larvae found in 0.1120 of upper haul, no larvae found in 0.1667 of lower haul, and no large larvae in entire lower haul.
[20] Before applying the regular adjustments the count in the upper haul was multiplied by 4 to adjust for the accidental loss of ¾ (estimated) of the plankton.

TABLE 20.—*Record of mackerel larvae caught on cruises VIII and IX*

[Column A gives the actual count, Column B the standardized total. Sizes under 7 mm. in length have been omitted on account of their incomplete retention by the 2-meter stramin net used on this cruise]

CRUISE VIII, JUNE 26 TO JULY 1, 1932

Length in millimeters	Martha's Vineyard				Montauk		Shinnecock				New York									
	I (1283)		II (1282)		IV (1259)		I (1275)		II (1274)		I (1270)		II (1271)		III (1272)		V (1260)		VI (1261)	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
7	5	0.68					81	11.41			21	2.88	8	0.70			1	0.04		
8	6	.81					96	13.54			18	2.47	7	.62	1	0.07	1	.04		
9	4	.54	5	0.68			46	6.48			32	4.39	11	.97	2	.15				
10			1	.14			29	4.09			21	2.88	11	.97	6	.44	1	.04		
11			1	.14	2	0.27	9	1.27			8	1.10	25	2.20	3	.22	2	.09	1	0.08
12							8	1.13			2	.27	15	1.32	3	.22	2	.09		
13							1	.14	1	0.26			3	.26	1	.07				
14					1	.14							5	.44						
15							2	.28					1	.09						
16													1	.09			2	.09		
17																				
18													1	.09						
19							1	.14					1	.09						
20									1	.26										
21																				
22							1	.14												
Total	15	2.03	7	.96	3	.41	274	38.62	2	.52	102	13.99	89	7.84	16	1.17	9	.39	1	.08

Length in millimeters	Barnegat		Atlantic City								Cape May						Total	
	I (1269)		I (1262)		II (1263)		III (1264)		IV (1265)		II (1266)		III (1267)		IV (1268)			
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
7	3	0.39	156	20.45					2	0.54	1	0.12					275	36.55
8	2	.26	87	11.40	1	0.25											222	30.12
9	2	.26	14	1.84			4	1.02	1	.27							121	16.60
10			4	.52			1	.25	1	.27							75	9.60
11					1	.25									2	0.16	54	5.78
12					1	.25	1	.25	1	.27							33	3.80
13															1	.08	7	.81
14					1	.25									3	.24	10	1.07
15													1	0 20	1	.08	5	.65
16													1	.20	1	.08	5	.46
17													1	.20			1	.20
18																	1	.09
19																	2	.23
20																	1	.26
21																		
22																	1	.14
Total	7	.91	261	34.21	4	1.00	6	1.52	5	1.35	1	.12	3	.60	8	.64	813	106.36

TABLE 20.—*Record of mackerel larvae caught on cruises VIII and IX*—Continued

CRUISE IX, JULY 16-24, 1932

Length in millimeters	Cape Ann II (1319)		Boston II (1318)		Cape Cod Bay I (1316)		Chatham II (1328)		Western Georges III (1308)		South Channel IV (1307)		Martha's Vineyard I (1303)		Martha's Vineyard II (1302)		Montauk I (1288)		Montauk II (1290)		Shinnecock I (1294)		New York II (1296)		Total	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
7			8	2.26							1	0.21	10	1.10			5	0.50			96	4.80			120	8.87
8			13	3.67					1	0.68			10	1.10			2	.20			232	11.60			258	17.25
9			10	2.72					1	.68			10	1.10							74	3.70			95	8.20
10			7	1.97	1	0.11	2	0.51					5	.55							6	.30			21	3.44
11			3	.85									2	.22	3	0.77					1	.05			9	1.89
12			2	.56			2	.51					1	.11											5	1.18
13													1	.11											1	.11
14	1	0.11					1	.26																	2	.37
15							1	.26																	1	.26
16	1	.11							1	.68															2	.79
17																							1	0.12	1	.12
19	1	.11																							1	.11
20							1	.26																	1	.26
21							2	.51																	2	.51
22							1	.26																	1	.26
23							4	1.02							1	.26									5	1.28
24							1	.26																	1	.26
25							3	.77																	3	.77
26							3	.77											1	0.19					4	.96
27							5	1.28																	5	1.28
28							5	1.28																	5	1.28
30							1	.26																	1	.26
37							1	.26																	1	.26
51	1	.11																							1	.11
Total	4	.44	43	12.03	1	.11	33	8.47	3	2.04	1	.21	39	4.29	4	1.03	7	.70	1	.19	409	20.45	1	.12	546	50.08

NOTE.—In addition to the above, hauls which yielded no mackerel material were made during cruise VIII at New York IV on June 29, Montauk I, II, and III on June 30, and Martha's Vineyard III and IV on July 1; and during cruise IX at Montauk II and IV and Shinnecock II and III on July 17, at New York I, III, and IV on July 18, at New York V and Martha's Vineyard III and IV on July 19, at Nantucket Shoals I, II, and III on July 20, at South Channel II and Western Georges I and II on July 21, at South Channel I, Chatham I, Nanset I, Race Point I and Boston Light I on July 22, at Cape Anne I, Newburyport I, Boone Island I, and Cape Elizabeth I and II on July 23, at Boone Island II, Cape Anne III, and Race Point II on July 24, 1932.

SIZES OF YOUNGEST POST-PLANKTONIC MACKEREL

To afford comparison between the largest tow-netted mackerel and smallest sizes caught by other gear, there are given in table 21 the length frequencies of several samples selected for their pertinence to this subject. The measurements were taken to the nearest half centimeter on a straight line from the snout to the fork of the tail.

TABLE 21.—*Sizes of young mackerel in the earliest available samples of post-planktonic stages in 1926, 1927, and 1932*

[The sample of July 22, 1926, was taken by dip net in the boat basin at the Fisheries Biological Station at Woods Hole, Mass. The other samples of 1926 and those of 1927 were taken by dip net in pound nets in the vicinity of Woods Hole, Mass.; and the 1932 sample came from the commercial catch of a pound net in the vicinity of Montauk, N. Y.]

Length in millimeters	July 22, 1926	Aug. 4, 1926	Aug. 8, 1926	July 28, 1927	Aug. 3-4, 1927	Aug. 30, 1932
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
35	1					
40	8					
45	5			2		
50	5			1		
55	8					
60	7					
65	1				2	
70		1	1		6	
75		2	1		6	
80			1		3	
85		2			1	
90		1			5	
95			1		32	
100		1			96	
105					100	
110					30	
115					2	
145						1
150						1
155						10
160						5
165						6
170						3
Total	35	7	4	3	283	26

LITERATURE CITED

BIGELOW, HENRY BRYANT. 1927. Physical oceanography of the Gulf of Maine. Bull. U. S. Bur. Fish. vol. 40, part 2, Document No. 969, Dec. 12, 1927, pp. 511–1027, figs. 1–207.

BIGELOW, HENRY BRYANT. 1933. Studies of the waters on the continental shelf, Cape Cod to Chesapeake Bay. I. The cycle of temperature. Papers in Physical Oceanography and Meteorology, vol. 11, No. 4. Contrib. No. 34.

BIGELOW, HENRY BRYANT, and MARY SEARS. 1939. Studies of the waters of the continental shelf, Cape Cod to Chesapeake Bay. III. A volumetric study of the zooplankton. Memoirs of the Museum of Comparative Zoology, vol. LIV, No. 4.

BIGELOW, HENRY BRYANT, and WILLIAM W. WELSH. 1925. Fishes of the Gulf of Maine. Bull. U. S. Bur. Fish., vol. 40, part 1, Document No. 965, pp. 1–567, figs. 1–278.

BJERKAN, PAUL. 1919. Results of the hydrographical observations made by Dr. Johan Hjort in the Canadian Atlantic waters during the year 1915. Dept. of the Naval Service. Canadian Fisheries Expedition, 1914–15, pp. 349–403, 4 pls., 11 figs., Ottawa.

BRICE, JOHN J. 1898. The common mackerel. In a manual of fish culture based on the methods of the United States Commission of Fish and Fisheries. Rept. U. S. Commission of Fish and Fisheries for 1897, pp. 209–213, pls. LVIII.

BUCHANON-WOLLASTON, H. J. 1935. On the component of a frequency distribution ascribable to regression. Jour. du Conseil, vol. X, No. 1, pp. 81–98.

CARRUTHERS, J. N. 1938. Fluctuations in the herrings of the East Anglian autumn fishery, the yield of the Ostend spent herring fishery, and the haddock of the North Sea in the light of relevant wind condition. Cons. Perm. Internat. p. l'explor. de la Mer, Rapp. et Proc.-Verb. CVII, 3e'me Pt. 10–15.

CARRUTHERS, J. N., and W. C. HODGSON. 1937. Similar fluctuations in the herrings of the East Anglian autumn fishery and certain physical conditions. Cons. Perm. Internat. p. l'explor. de la Mer, Rapp. et Proc.-Verb. CV, 3e'me Pt. 10–13, Copenhagen.

CLARK, FRANCES N. 1934. Maturity of the California sardine (*Sardina caerulea*) determined by ova diameter measurements. Calif. Div. Fish and Game. Fish Bull. 42; 49 pp., 19 figs.

DANNEVIG, ALF. 1919. Canadian fish-eggs and larvae. Canadian Fisheries Expedition, 1914–15, pp. 1–74, 3 pls., 26 figs., Dept. of Naval Service, Ottawa.

EHRENBAUM, E. 1921. Ueber die Makrele. Wissensch. Meeresuntersuchungen. Abt. Helgoland. Bd. XV. No. 2, 1921.

EMBODY, GEORGE CHARLES. 1910. The ecology, habits and growth of the pike, *Esox lucius*. Unpublished thesis deposited in the library of Cornell University.

EZEKIEL, MORDECAI. 1930. Methods of correlation analysis. John Wiley & Sons, Inc., New York, 1930.

FIEDLER, REGINALD HOBSON. 1932. Fishery industries of the United States, 1931. Report of U. S. Commissioner of Fisheries for the fiscal year 1932, App. II. Oct. 12, 1932, pp. 97–440.

FIEDLER, REGINALD HOBSON, JOHN RUEL MANNING, and FRED FRANCIS JOHNSON. 1934. Fishery industries of the United States, 1933. Report of U. S. Commissioner of Fisheries for the fiscal year 1934, App. I. Aug. 17, 1934, pp. 1–237.

FISH, CHARLES JOHN. 1928. Production and distribution of cod eggs in Massachusetts Bay in 1924 and 1925. Bull. U. S. Bur. Fish., vol. 43, pt. 2. Document No. 1032, Feb. 25, 1928, pp. 253–296, figs. 1–16.

FISHER, R. A. 1932. Statistical methods for research workers. Oliver and Boyd, Edinburgh.

GOODE, GEORGE BROWN. 1884. The mackerel (*Scomber scombrus*) in Fishery Industries of the United States. Natural Hist. of Useful Aquatic Animals. Sect. 1, pp. 281–303, U. S. Govt. Printing Office.

GARSTANG, WALTER. 1898. On the variation, races, and migrations of the mackerel, *Scomber scombrus*. Jour. Marine Biol. Assoc., vol. V, No. 3, pp. 235–295.

HJORT, JOHAN. 1926. Fluctuations in the year class of important food fishes. Jour. du Conseil, Feb. 1926, vol. I, No. 1, pp. 5–39.

HUNTSMAN, A. G. 1919. Some quantitative and qualitative plankton studies of the Eastern Canadian plankton. Canadian Fisheries Expedition, 1914–15, pp. 405–485, 12 figs., Dept. of Naval Service, Ottawa.

ISELIN, COLUMBUS O'DONNELL. 1936. A study of the circulation of the western N. Atlantic. Papers in Physical Oceanography and Meteorology. Vol. IV, No. 4, August 1936.

MARSHALL, S. M., A. G. NICHOLLS, and A. P. ORR. 1937. On the growth and feeding of the larval and post-larval stages of the Clyde herring. Jour. Marine Biol. Assoc., vol. XXI, No. 1, Nov. 1937, pp. 245–267.

MOORE, J. PERCY. 1899. Report on mackerel investigations in 1897. Report Commissioner, U. S. Comm. Fish and Fisheries for 1898, [App. I.,] pp. 1–22.

RUSSELL, F. S. 1925. Depth recording with plankton-nets. Nature, vol. CXV, 1925, pp. 603–604. London.

SETTE, OSCAR ELTON. 1931. Outlook for the mackerel fishery in 1931. Fishery Circular No. 4, Bur. of Fish., U. S. Dept. Commerce, Aug. 1931, pp. 1–20.

SETTE, OSCAR ELTON. 1932. Outlook for the mackerel fishery in 1932. Fishery Circular No. 10, Bur. of Fish., U. S. Dept. Commerce, June 1932, pp. 1–25.

SETTE, OSCAR ELTON. 1933. Outlook for the mackerel fishery in 1933. Fishery Circular No. 14, Bur. of Fish., U. S. Dept. Commerce, May 1933, pp. 1–23.

SETTE, OSCAR ELTON. 1934. Outlook for the mackerel fishery, 1934. Fishery Circular No. 17, Bur. of Fish., U. S. Dept. Commerce, April 1934, pp. 1–6.

SETTE, OSCAR ELTON. 1938. Relative strength of year classes of certain fishes of the Western Atlantic. E. Mackerel. Cons. Perm. Internat. p. l'explor. de la mer, Rapp. et Proc.-Verb. CI, 4e'me, Pt. 1, Copenhagen.

SETTE, OSCAR ELTON, and A. W. H. NEEDLER. 1934. Statistics of the mackerel fishery off the east coast of North America, 1804 to 1930. Inv. Rept. No. 19, Bur. of Fish., U. S. Dept. of Commerce, 1934, pp. 1–48.

SPARKS, M. IRVING. 1929. The spawning and development of mackerel on the outer coast of Nova Scotia. Contrib. to Canad. Biol. and Fisheries, N. S., vol. IV, No. 28, pp. 443–452.

WALFORD, LIONEL ALBERT. 1938. Effect of currents on distribution and survival of the eggs and larvae of the haddock (*Melanogrammus aeglefinus*) on Georges Bank. Bull. U. S. Bur. Fish., vol. 49, Bull. No. 29, pp. 1–73, figs. 1–50.

WILSON, HENRY V. P. 1891. The embryology of the sea bass (*Serranus atrarius*). Bull. U. S. Fish. Comm., vol. 9, Document No. 160, July 7, 1891, pp. 209–277, pl. LXXXVIII–CVII, text-figs. 1–12.

WINSOR, CHARLES P., and LIONEL A. WALFORD. 1936. Sampling variations in the use of plankton nets. Jour. du Conseil, vol. XI, No. 2, pp. 190–204.

WORLEY, LEONARD G. 1933. Development of the egg of the mackerel at different constant temperatures. Jour. Gen. Physiology, vol. 16, No. 5, pp. 841–857.

○